REPORT DOC | AD-A255 255 | Form Approved OMB No. 0704-0188



**1. AGENCY USE ONLY** *(Leave blank)*

**...AND DATES COVERED**
Scientific Paper

**4. TITLE AND SUBTITLE**
A "Green Wars" Challenge to EOSAEL

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**

Richard B. Gomez

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

U.S. Army Topographic Engineering Center
ATTN: CETEC-LO
Fort Belvoir, VA 22060-5546

**8. PERFORMING ORGANIZATION REPORT NUMBER**
R-189



**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

**12a. DISTRIBUTION/AVAILABILITY STATEMENT**

Approved for public release;
Distribution is unlimited.

**12b. DISTRIBUTION CODE**

**13. ABSTRACT** *(Maximum 200 words)*

On 10 Oct. 89, Secretary of Defense Richard B. Cheney, in response to the growing environmental concerns, spelled out environmental management policy which substantially broadened the role of the Defense Department to include saving our environment. Earlier this year, Chief of Engineers LTG Henry J. Hatch noted that U.S. security objectives have changed, resulting in a broader perception of national security. Among other threats to national security, he mentioned the environmental degradation as a major factor of global significance. And Georgia's Senator Sam Nunn, chairman of the Senate Armed Services Committee, reasoning that warmer Soviet-American relations may leave the Department of Defense with a reduced mission, has suggested that defense money and manpower be directed into saving the environment. He has proposed that the Secretary of Defense establish a program to be known as the Strategic Environmental Research Program, to address these environmental matters of concern through focused research and development. The message is clear, environmental destruction is a threat to national security.

**14. SUBJECT TERMS**
Nonmilitary aspects of national security
Environmental degradation
Strategic Environmental Research Program

**15. NUMBER OF PAGES**
5

**16. PRICE CODE**

| 17. SECURITY CLASSIFICATION OF REPORT | 18. SECURITY CLASSIFICATION OF THIS PAGE | 19. SECURITY CLASSIFICATION OF ABSTRACT | 20. LIMITATION OF ABSTRACT |
|---|---|---|---|
| UNCLASSIFIED | UNCLASSIFIED | UNCLASSIFIED | |

## GENERAL INSTRUCTIONS FOR COMPLETING SF 298

The Report Documentation Page (RDP) is used in announcing and cataloging reports. It is important that this information be consistent with the rest of the report, particularly the cover and title page. Instructions for filling in each block of the form follow. It is important to ***stay within the lines*** to meet ***optical scanning requirements***.

**Block 1.** Agency Use Only *(Leave blank)*.

**Block 2.** Report Date. Full publication date including day, month, and year, if available (e.g. 1 Jan 88). Must cite at least the year.

**Block 3.** Type of Report and Dates Covered. State whether report is interim, final, etc. If applicable, enter inclusive report dates (e.g. 10 Jun 87 - 30 Jun 88).

**Block 4.** Title and Subtitle. A title is taken from the part of the report that provides the most meaningful and complete information. When a report is prepared in more than one volume, repeat the primary title, add volume number, and include subtitle for the specific volume. On classified documents enter the title classification in parentheses.

**Block 5.** Funding Numbers. To include contract and grant numbers; may include program element number(s), project number(s), task number(s), and work unit number(s). Use the following labels:

| | | | |
|---|---|---|---|
| **C** | Contract | **PR** | Project |
| **G** | Grant | **TA** | Task |
| **PE** | Program Element | **WU** | Work Unit Accession No. |

**Block 6.** Author(s). Name(s) of person(s) responsible for writing the report, performing the research, or credited with the content of the report. If editor or compiler, this should follow the name(s).

**Block 7.** Performing Organization Name(s) and Address(es). Self-explanatory.

**Block 8.** Performing Organization Report Number. Enter the unique alphanumeric report number(s) assigned by the organization performing the report.

**Block 9.** Sponsoring/Monitoring Agency Name(s) and Address(es). Self-explanatory.

**Block 10.** Sponsoring/Monitoring Agency Report Number. *(If known)*

**Block 11.** Supplementary Notes. Enter information not included elsewhere such as: Prepared in cooperation with...; Trans. of...; To be published in.... When a report is revised, include a statement whether the new report supersedes or supplements the older report.

**Block 12a.** Distribution/Availability Statement. Denotes public availability or limitations. Cite any availability to the public. Enter additional limitations or special markings in all capitals (e.g. NOFORN, REL, ITAR).

- **DOD** - See DoDD 5230.24, "Distribution Statements on Technical Documents."
- **DOE** - See authorities.
- **NASA** - See Handbook NHB 2200.2.
- **NTIS** - Leave blank.

**Block 12b.** Distribution Code.

- **DOD** - Leave blank.
- **DOE** - Enter DOE distribution categories from the Standard Distribution for Unclassified Scientific and Technical Reports.
- **NASA** - Leave blank.
- **NTIS** - Leave blank.

**Block 13.** Abstract. Include a brief *(Maximum 200 words)* factual summary of the most significant information contained in the report.

**Block 14.** Subject Terms. Keywords or phrases identifying major subjects in the report.

**Block 15.** Number of Pages. Enter the total number of pages.

**Block 16.** Price Code. Enter appropriate price code *(NTIS only)*.

**Blocks 17. - 19.** Security Classifications. Self-explanatory. Enter U.S. Security Classification in accordance with U.S. Security Regulations (i.e., UNCLASSIFIED). If form contains classified information, stamp classification on the top and bottom of the page.

**Block 20.** Limitation of Abstract. This block must be completed to assign a limitation to the abstract. Enter either UL (unlimited) or SAR (same as report). An entry in this block is necessary if the abstract is to be limited. If blank, the abstract is assumed to be unlimited.

# A "GREEN WARS" CHALLENGE TO EOSAEL

Richard B. Gomez
U.S. Army Engineer Topographic Laboratories
Fort Belvoir, Virginia 22060-5546, United States of America

## ABSTRACT

On 10 October 1989, Secretary of Defense Richard B. Cheney, in response to the growing environmental concerns, spelled out environmental management policy which substantially broadened the role of the Defense Department to include saving our environment. Earlier this year, Chief of Engineers LTG Henry J. Hatch noted that U.S. security objectives have changed, resulting in a broader perception of national security. Among other threats to national security, he mentioned the environmental degradation as a major factor of global significance. And Georgia's Senator Sam Nunn, chairman of the Senate Armed Services Committee, reasoning that warmer Soviet-American relations may leave the Department of Defense with a reduced mission, has suggested that defense money and manpower be directed into saving the environment. He has proposed that the Secretary of Defense establish a program to be known as the Strategic Environmental Research Program, to address these environmental matters of concern through focused research and development. The message is clear, environmental destruction is a threat to national security.

Because of this recognition of nonmilitary aspects of national security, also referred to as "Green Wars", the role of the Army is broadening, and this will dictate a broadening of EOSAEL's efforts as well. The challenges in protecting and restoring our environment are far greater than is generally recognized, and EOSAEL is in a position to emerge as a major resource to address these transnational issues. The full extent of the Army's involvement in environmental issues such as global change, pollution, and acid rain is still evolving. However, EOSAEL represents a valuable data base and a model for assisting the nation in dealing with such issues, and should be broadened to meet the challenge. In the final analysis, EOSAEL may prove to be a major potential weapon on the environmental war.

## 1. INTRODUCTION

Secretary of Defense Dick Cheney has stated that "The first priority of our environmental policy, must be to integrate and budget environmental considerations into our activities and operations. This will decrease our future liabilities and costs for our people. The effort begins and ends with our people." He further stated, "We must be fully committed to do our part to meet the worldwide environmental challenge and I know I can count on your support to ensure that we are successful in that effort." (Cheney, 1990).

Earlier this year, LTG Henry J. Hatch, Chief of Engineers, noted that U.S.security objectives have changed, resulting in a broader perception of national security. From his perspective, the concept of a strategic force (and the Army is a strategic force) involves two dimensions. "The first of these is that the Army must be prepared for war fighting. The `other' dimension is that the Army must be prepared to address a broad range of national security concerns during peacetime. This `other' dimension of a strategic force is not a secondary role," he said. Among other threats to national security, he mentions the environmental degradation as a major factor of global significance. "I can assure you," he said, "that the destruction of our global environment and its rapid impact on all species of life, including man, is certainly a national issue. The questions for the Army are the degree of threat and what the Army's response should be." (Hatch, 1990).

And Georgia's Senator Sam Nunn, chairman of the Senate Armed Services Committee, reasoning that warmer Soviet-American relations may leave the Defense Department with a reduced mission, has suggested that defense money and manpower be directed into saving the environment. He has proposed that the Secretary of Defense establish a program to be known as the Strategic Environmental Research Program (SERP), to address these environmental matters of concern through focused research and development. (Lemonick, 1990).

Because of this recognition of nonmilitary aspects of national security, also referred to as "Green Wars", the role of the Army is broadening, and this will dictate a broadening of the role that the Electro-Optical Systems Atmospheric Effects Library (EOSAEL) plays within the atmospheric community. EOSAEL can provide new tools to evaluate effectively how to respond to global environmental changes so we can understand and properly manage our changing planet. President Bush has pointed out the need for these tools and has called out for us to join together and accept the challenge of Global Stewardship. (Bush, 1990).

## 2. THE VISION

Back in the seventies, the problem of assessing the performance of electro-optical systems operating under battlefield environmental conditions was not being adequately addressed. To properly address this serious problem, an approach was adopted by the Tri-Service atmospheric community that called for the development and validation of a library of algorithms and computer codes that accurately describe the atmospheric effects on E-O sensors. The computer modeling portion of this approach was carried out by the U.S. Army Atmospheric Sciences Laboratory (ASL) under the program entitled "Electro-Optical Sensor Atmospheric Effects Library (E-O SAEL)." The objective of the ASL E-O SAEL program, now referred to as the Electro-Optical Systems Atmospheric Effects Library or EOSAEL, was and still is, the development and validation of an operational propagation computer code or library of computer codes for the accurate representation of the effects of atmospheric aerosols, gases, and battlefield-induced contaminants on the effectiveness of the E-O sensors/systems. In simpler terms, the current EOSAEL program addresses the major atmospheric effects that affect Army electro-optical systems performance. The future EOSAEL program should be broadened to

address the effects of man and nature on the environment. We not only need to develop a better understanding of how atmospheric effects influence imaging, LIDAR, and other electro-optical systems, but we also need to translate this new understanding into products that both the military and civil communities can use. We need to develop the tools and capacity for the military community to join forces with the civil community to help save the environment. The message is clear, atmospheric optics technology needs to become more usable and user friendly to the military and civil communities. From the start, it has been the philosophy of the EOSAEL strategy that EOSAEL computer codes be modular, simple and understandable, adaptive, easy to control, complete in important matters, and easy to communicate with. (Gomez, 1978). So this part of the message is nothing new to EOSAEL. What is new, is that the user now comes not only from the military side but also from the civil side.

## 3. THE CHALLENGE

New EOSAEL modules could be developed to account for atmospheric pollution, acid rain, atmospheric nuclear contamination patterns or global warming. However, the greatest need right now is for EOSAEL to help with the exploitation of hyperspectral imagery in support of both civil and military missions. EOSAEL can make major modeling contributions to "backing out" the atmospheric effects from the hyperspectral imagery. This atmospheric backout problem is becoming more critical for spectral analysis applications, particularly those involving spectral and imagery technologies. EOSAEL could help by providing for corrections of satellite image radiometric errors arising from external sources (atmospheric emission, scattering, and absorption) and internal sources (detector response and calibration). Current EOSAEL modules could be expanded to do this job. However, with the advent of imagery technology that permits us to acquire digital meteorological data directly, we have to cope with the problem of processing and storing the massive amount of data available to drive the EOSAEL modules. The data can be real-time or recorded. The data can be coming from many sources, singly or in combination. Data sources can include polar orbiting satellites (TIROS-N), geostationary satellites (GOES), grid point data (multiple ground and airborne sensors), surface and sounding data (profilers), and digital radar weather data (NEXRAD). Today, we routinely process imagery data at a conservative rate of 200 points per second. Assuming 100 megapoints per scene are coming in, which is on the low side, it would take us 500,000 seconds, or almost six days to process the data for one scene. Even with a hundred-fold increase in the rate of processing, it would take us 83 minutes to process the data for that scene. The bottom line is that our ability to acquire data exceeds our ability to process it. The challenge is to better define what information is needed to achieve the end product, and with that, put limits on the data that is required. Sensitivity analysis needs to be emphasized to determine the relative importance of data types and the degree of resolution and precision needed in the data to accomplish the EOSAEL task. A significant and crucial study in this subject area that was concluded ten years ago, documented in the ASL report entitled "Atmospheric Data Requirements For Battlefield Obscuration Applications" (Holt, et al., 1980), should be reinstituted to address atmospheric data requirements for hyperspectral imagery applications.

The long term goal of EOSAEL should be to seek civil and military applications where atmospheric sciences research can be applied not only to achieve optimum use of meteorological data accession systems, but also to address the subtle complexities of spectral image interpretation that is made more difficult by the use of atmospheric affected hyperspectral imagery. This is a real challenge.

## 4. THE PAYOFF

Hundreds of millions of dollars are spent yearly in support of civil missions. Data collection and analysis are major cost drivers. If imagery and spectral technologies can be exploited to reduce these costs, the savings would be tremendous. One approach to accomplishing the data collection mission is by performing simultaneous imaging of the ground at multiple frequencies from a spaceborne remote sensor and examining the clues provided by the spectral signatures of objects on the ground. Hyperspectral imaging sensors, which acquire or have access to many hundreds of spectral channels, are well suited for this data collection purpose. The resultant hyperspectral image cube is a three dimensional spatial-spectral data set with two axes of spatial information and one axis of spectral information. The use of hyperspectral sensors places severe demands upon image processing systems, analysis algorithms, image cube display, and data storage systems. This new data acquisition capability must be paralleled by equal advancements in modeling and analysis techniques which include accounting for the atmospheric effects. I maintain that EOSAEL can make important, unique contributions to emerging environmental programs, particularly those exploiting hyperspectral imagery, and in the process save civil money and secure federal funds to keep our atmospheric propagation modeling programs hale and hearty during the lean years ahead for defense. I strongly believe that "Green Wars" programs will help offset imminent military budget cuts. Involvement in the cutting edge of both spectral technology and imagery technology to find solutions to our environmental problems will produce an air of technological excitement that will help the EOSAEL community maintain our technological edge in the renewed field of atmospheric propagation.

## ACKNOWLEDGMENT

The stimulating discussions on the subject that I had with John Hansen, Director of the Research Institute, U.S. Army Engineer Topographic Laboratories, Fort Belvoir, Virginia, are gratefully acknowledged.

## REFERENCES

Bush, G. H. W., 1990: GLOBAL STEWARDSHIP, A Statement of the Context and Challenges Facing the White House Conference on Science and Economics Research Related to Global Change.

Cheney, R. B., 1989: Secretary Of Defense Memorandum for Secretaries of the Military Departments, 10 October 1989, Subject: Environmental Management Policy.

Gomez, R. B., 1978: Atmospheric Sciences Laboratory Plan for Determining Atmospheric Effects on Electro-Optical Systems Operating in a Battlefield Environment, January 1978, Atmospheric Sciences Laboratory, White Sands Missile Range, New Mexico.

Hatch, H. J., 1990: Beyond the Battlefield--The Other Dimension of Military Service, Engineer, 20, 12-19.

Holt, E. H., et al., 1980: Atmospheric Data Requirements for Battlefield Obscuration Applications, ASL-TR-0061, Atmospheric Sciences Laboratory, White Sands Missile Range, New Mexico.

Lemonick, M. D., 1990: Letting the Earth Breathe Easier, Time, 63-64.